VicRoads

St Kilda Street Bridge

Heritage Recognition Nomination

February 2015

Front Cover Photograph:

Load Test, 20 November 1905. University of Melbourne Archives,
Reinforced Concrete & Monier Pipe Construction Co Collection, GPNB/1094.

Image: Alan Holgate

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1. Introduction

The St Kilda Street Bridge has been nominated for recognition as an Engineering Heritage Marker under the Engineering Heritage Recognition Program.[1] Engineering Heritage Victoria has been looking for opportunities to recognise heritage engineering sites relating to the work of General Sir John Monash in the lead up to the centenary of the Landings at Anzac Cove in April 2015.

The St Kilda Street Bridge crosses the Elwood Canal on St Kilda Street and is located approximately 10 km south of Melbourne (Figure 1). The purpose of the following Formal Nomination is to provide sufficient information for the Engineering Heritage Recognition Committee to determine whether the St Kilda Street Bridge warrants recognition under the Engineering Heritage Recognition Program.

The St Kilda Street Bridge was designed and constructed in 1905 by civil engineer General Sir John Monash of the Reinforced Concrete & Monier Pipe Construction Company. The St Kilda Street Bridge construction marks a turning point in the use of reinforced concrete in not only civil construction but also in the construction of buildings. The bridge demonstrates the technical innovation achieved by General Sir John Monash in the early years of the twentieth century and the earliest stage in the development of reinforced concrete technology in Australia. As the oldest extant reinforced concrete beam bridge in Victoria and possibly Australia, the bridge is an important addition to the list of sites of significance recognised by the Engineering Heritage Recognition Program and furthers key objectives determined by Engineering Heritage Victoria.

[1]Engineers Australia (EA) established an Australian Historical Engineering "Plaguing" Program in 1984 in order to recognise both engineers and engineering works of historic and heritage significance within Australia. The Program is now named the "Engineering Heritage Recognition Program".
A list of engineering works currently recognised by a Heritage Recognition Award can be viewed on the Engineering Heritage Australia website: www.engineeringheritage.com.au.

Figure 1 Location Plan

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2. Heritage Nomination letter

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Sunshine Victoria 3020
Telephone (03) 9313 1333

Send Correspondence to:
mnw.mail@roads.vic.gov.au
or Fax (03) 9313 1175

Parcels and Drawings to:
Private Bag 4000 Sunshine
Victoria 3020

vicroads.vic.gov.au

Mr Owen Peake
Engineering Heritage Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Contact: Steve Di Cicco
Telephone: 9313 1207
Our Ref: 2848936

Dear Mr Peake

ST. KILDA STREET BRIDGE HERITAGE AWARD NOMINATION

I refer to your request seeking VicRoads' approval for the St. Kilda Street Bridge nomination as part of the Heritage Recognition Program of Engineering Heritage Australia.

I wish to inform you that VicRoads approves the nomination of the St. Kilda Street Bridge under the Heritage Recognition Program of Engineering Heritage Australia.

Significant engineering heritage works are those that have been judged to be valuable to a group of people, or have contributed something of value to the nation, a region or the practice of engineering.

The St Kilda Street Bridge demonstrates the earliest stage in the development of reinforced concrete girder technology for bridge building. It is the earliest extant example in Victoria, and possibly in Australia, of the technological innovation achieved by John Monash.

The engineering heritage recognition is timely in 2015, as it is the centenary anniversary of the ANZAC landings at Gallipoli in which John Monash participated.

The St. Kilda Street Bridge interpretation panel will be installed at St. Kilda Street, south-west of the bridge adjacent to the shared user path.

Should you require any further information, Mr Steve Di Cicco, VicRoads' Manager Structures – Metropolitan North West Region (Tel: 9313 1207) would be pleased to assist.

Yours sincerely

ADAM MAGUIRE
REGIONAL DIRECTOR

30 / 2 / **2015**

State Government Victoria

VicRoads ABN 61 760 960 480

PSL 38

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of work: St. Kilda Street Bridge Nomination

This work is nominated for an award under the Heritage Recognition Program of Engineers Australia.

Location, including address and map grid reference if a fixed work:
St Kilda Street, Elwood, Melbourne.
Melways Ref: 67 D4

Owner (name & address): VicRoads (Metro North West)
499 Ballarat Road, Sunshine Vic 3020

The owner has been advised of this nomination and a letter of agreement is attached.

Access to site: via St Kilda Street, Elwood.

Nominating Body: VicRoads (Metro North West)

.....
Chair of Nominating Body
Date: 8/2/15

Owen Peake
Chair, Engineering Heritage Victoria.
Chair of Divisional EHA Group
Date: 8/2/15

3. Heritage Assessment

3.1 Eligibility

The following assessment outlines the eligibility of the St Kilda Street Bridge for a national heritage award under the Engineering Heritage Recognition program:

Item Name: St Kilda Street Bridge

Former Names: Elwood Canal Bridge

Location: Crossing the Elwood Canal (formerly known as Elster Creek). The bridge carries St Kilda Street. The bridge is located between Glen Huntly Road and Spray Street (Coordinates -37.8859, 144.99173).

Address: Elwood Victoria 3184. Melway Map No.67, reference D4

Suburb/Nearest Town: Elwood

State: Victoria

Local Government Area: City of Port Phillip

Previous Owner: Victorian Public Works Department

Owner: Vicroads, Metro North West

Former/Current Use: Road Bridge (including pedestrian use)

Designer: General Sir John Monash (1865-1931)

Maker/Builder: General Sir John Monash, Reinforced Concrete & Monier Piper Construction Company, Melbourne

Year Started: 1905

Year Completed: 1905

Physical Description: The Bridge consists of five-equal spans of 20 feet (6.1 m) with a 30 degree skew and a total width of 40 feet comprising of 30 feet of road carriageway and 10 feet for a footpath on the downstream side. The superstructure has seven lines of “T” girders spaced 4 feet 8 inches (1.42 m) apart. There are six columns supporting each span with no transverse beams supporting the deck slab. The columns are supported by individual spread footings in the form of a truncated pyramid. The column heads incorporate small corbels in the direction of the span. The abutments consist of a row of columns, each supporting the end of one girder, backed by precast concrete panels to retain the earth of the embankment. This bridge was built before the problem of shear strength of bridge girders became prominent and the middle 5 feet (1.5 m) of the span have no shear reinforcement.

Physical Condition: An assessment by engineering firm GHD Pty Ltd in August 2014 concluded that the bridge was in “poor” condition. There were considerable spalling and section loss of reinforcement to concrete elements. Test samples collected on the girders, columns and deck slab indicated concrete strength of 15 to 20 MPa which was normal at that time but considered low by modern standard. The bridge is currently in service and maintained by VicRoads albeit with considerable load restriction.

Modifications and Dates: Bridge may have been modified after initial construction.

3.2 Historical notes

3.2.1 The Elwood Swamp

Throughout the nineteenth century development within the Elwood region was severely hindered by the Elwood Swamp (also known as the Southern Swamp). The swamp comprised two large but shallow lagoons (up to a metre deep) situated between Dickens Street, Mitford Street, Glenhuntly Road and the beach (Figure 2).[2] Early attempts to solve the drainage problems in the low lying swampy land within Elwood were of limited effect.

In 1870, the Brighton Council cut a drain through Elsternwick Park to the Elwood swamp boundary at St Kilda Street. This led to increased drainage problems within the Elwood district. The St Kilda Council was forced to extend the drain to Port Phillip Bay in an attempt to reduce associated flooding within the region. Early parish plans note that this land was considered unusable, consequently 'withheld from sale, leasing and licensing, and exempted from occupation for mining purposes'.[3]

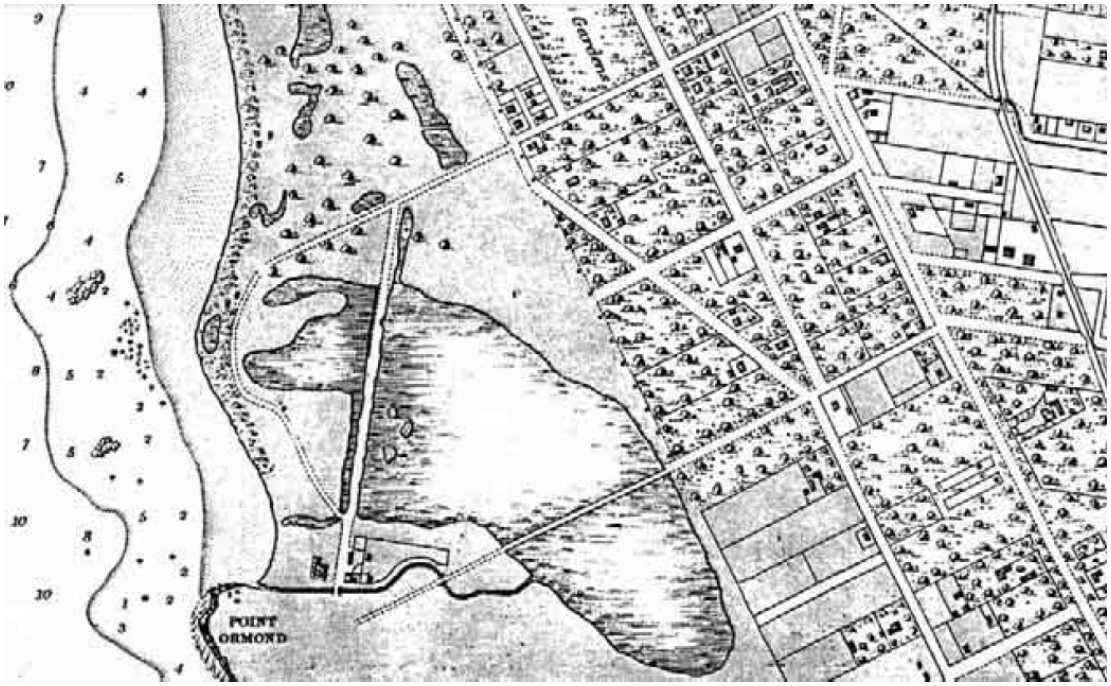

Figure 2 Cox's survey map of St Kilda in 1866, demonstrating the extent of the Elwood Swamp (source: Reeves 2005, p. 18)

Residential development within Elwood grew rapidly throughout the 1850s and 1860s. In the late 1880s the Public Works Department (PWD) undertook a scheme intending to fill the swamp and construct a canal that would extent from the sea to Glenhuntly Road. A large canal was excavated and the material obtained from it was redeposited in retaining banks on either side of the canal.[4] The Elwood Canal followed the alignment of the existing Ester Creek and was intended to drain the marshy land in the area. Concurrently, the Elwood Swamp was pumped vigorously with a centrifugal pumping plant capable of lifting 50,000 gallons per hour which was provided by contractors Messrs Hendon, Clarke and Anderson.[5] Construction of the canal began in May 1889 and was completed by 1897.

[2] S. Reeves and D. Wixted (2005). City of Port Phillip: Elwood Heritage Review. Volume 1: Thematic History Citations for Heritage Precincts. A Report by Heritage Alliance for the City of Port Phillip, Victoria, p. 24
[3] Ibid, p. 24
[4] The Elwood Swamp (1888, September 8). *The Telegraph, St Kilda, Prahran and South Yarra Guardian* (Vic.: 1866 - 1888), p. 6.
[5] The Elwood Swamp (1888, September 8). *The Telegraph, St Kilda, Prahran and South Yarra Guardian* (Vic.: 1866 - 1888), p. 2

Unfortunately the Elwood Canal did not effectively drain water from the bayside region. An engineer within the Railway Department, Mr Boan, described the ineffective outcomes in an official report outlined in The *Brighton Southern Cross Newspaper* in 1902:

> "The drain is quite inadequate, and during floods the water flows over the crown of St Kilda-street, from about 5in to 1ft deep for a distance of about 15 chains".[6]

Furthermore, the development of the Elwood Canal led to further issues with contamination and pollutants. This outcome was described in an article featured in *The Argus* in 1889, titled 'The Elwood Canal: A Plague Spot':

> "It was to have been some kind of Venetian canal, on which the residents expected to see gondolas floating, but it had become a sewer, and a sewer of the worse kind, for it had no outlet. The tide some four or five years ago had filled up the mouth, and the sewerage from about 90 square miles was turned into the canal…Dog, cats, and sheep were to be seen floating in it. One of the deputation had counted seven dead dogs in it one day".[7]

In 1905, the Public Works Department accepted a tender of £6000 for the clearing, filling up and lining of the Elwood Canal submitted by Messrs Hendon, Clarke & Anderson.[8] The contact also included the construction of the foundations for three bridges and repairs to the side walls of the canal.

A report published in *The Prahran Telegraph* in 1906 described the great improvement work within swamp land in Elwood, as a result of the Public Works Department improvement scheme:

> "The appearance of what has been known for so long as the Elwood Swamp, is now becoming something more in keeping with the happily-situated position and probably before many more years will be turned into one of the premier marine residential arrears (sic) fronting the bay".[9]

3.2.2 The St Kilda Street Bridge development

Formerly known as the Elwood Canal Bridge the St Kilda Street Bridge was designed and constructed in 1905 by renowned civil engineer John Monash (later General Sir John) and the Reinforced Concrete & Monier Pipe Construction Company. The bridge was built as part of a £30,000 Public Works Department scheme to solve ongoing drainage problems in the low lying swampy land of the Elsternwick and Elwood districts.

The Elwood Canal works provided Monash the opportunity to present to Carlos Catani, the then Chief Engineer of the Public Works Department, the reinforced concrete girder technology for bridge building, a cheaper alternative to the prevailing iron trough girder and concrete bridge technology (Figure 3).[10] Monash won the tender for the design and construction of the bridge on the condition that a 15 ton steam roller would be used to determine the solidity and load capacity of the bridge. Only half of the £1500 quotation fee would be paid before the bridge satisfactorily passed this test.

[6] Elster Creek (1902, May 31). *Brighton Southern Cross* (Vic.: 1896 - 1918), p. 2
[7] The Elwood Canal: A Plague Spot. (1898, October 20). *The Argus* (Melbourne, Vic.: 1848 - 1957), p. 10
[8] The Elwood Canal (1905, February 4). *Geelong Advertiser* (Vic : 1859 - 1924), p. 1
[9] Progress At Elwood. (1906, January 6). *The Prahran Telegraph* (Vic. : 1889 - 1930), p. 2
[10] A. Holgate and G. Taplin. 'Monash Bridges: Typology study of Reinforced Concrete Bridges in Victoria 1897-1917'

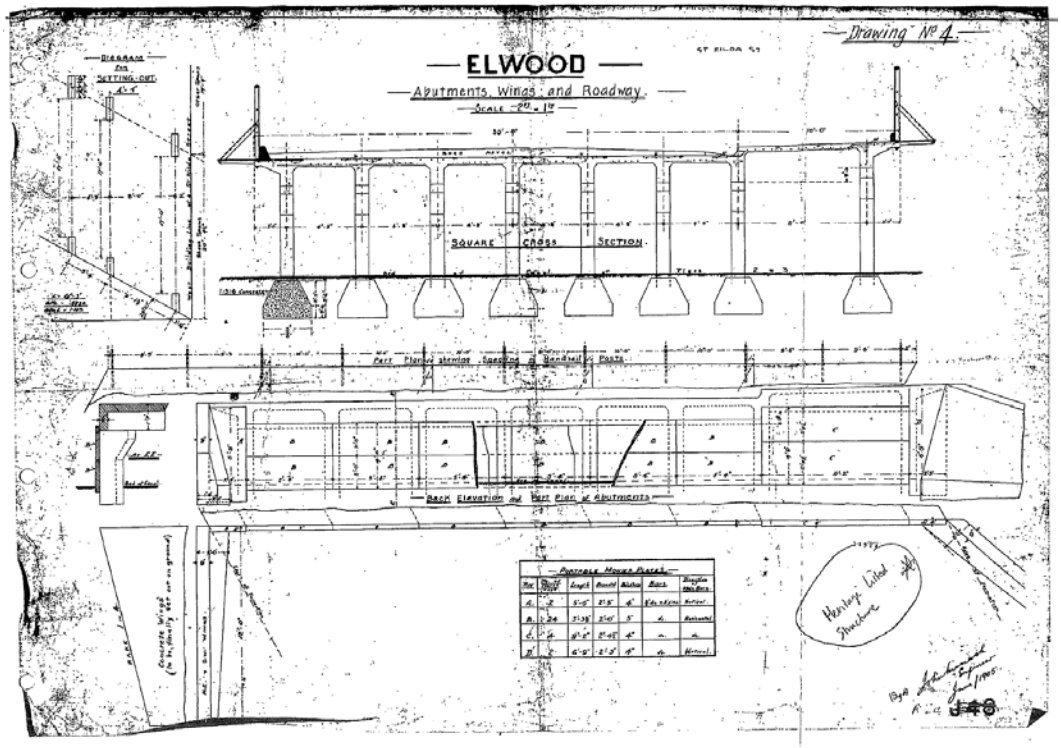

Figure 3 Preliminary sketch of the St Kilda Street Bridge (source: VicRoads Drawing No. 3)

The tender was submitted to the Public Works Department in April 1905. Construction of the bridge commenced in July and was completed by September 1905.[11] A conditional load test with a 15 ton steam roller was undertaken on 20 November 1905 in the presence of Catani, the St Kilda city surveyor and municipal representatives from Brighton and Caulfield.[12] The bridge carried the 15 ton steam roller without any perceptible vibrations or deflection.

Despite its technological innovation the St Kilda Street Bridge was opened the following week without great ceremony.

Between 1905 and 1907 seven bridges were built by the company in the Elwood district, six of these were situated across the Elwood Canal. Reinforced concrete was subsequently adopted as standard bridge building material in Victoria. The T-girder reinforced concrete bridge technique used to build the St Kilda Street Bridge was predated by one bridge erected at Stawell Street, Ballarat, in 1904. The bridge proved unsuccessful and was subsequently replaced. The St Kilda Street Bridge is now the oldest extant reinforced concrete beam bridge in Victoria and possibly Australia.

3.2.3 The Monier System

The Monier system of concrete construction was patented in 1867 by French gardener Joseph Monier. Monier was attempting to create a frost-resistant material for water pipes, and thereby discovered the advantages of Ferro-concrete. His 1867 patent for concrete flower pots, and his subsequent additional patent of 1878, the 'Monier Patent', were registered in a series of countries, including Australia.[13]

[11] S. Reeves and D. Wixted (2005). City of Port Phillip: Elwood Heritage Review. Volume 1: Thematic History Citations for Heritage Precincts. A Report by Heritage Alliance for the City of Port Phillip, Victoria, p. 2
[12] News of the Week (1905, December 30). *Brighton Southern Cross* (Vic.: 1896 - 1918), p. 4
[13] Gabriele Leuthauser (2001) Architecture in the Twentieth Century, Vol. 1. Taschen, Germany, p. 105

The Monier System was promoted in Australia by German migrant WJ Baltzer of Sydney based Gummow, Forrest & Company. John Monash, the son of Prussian Jewish migrants, consulted with Baltzer in developing the technology for bridge construction, having acquired the local rights for the Monier Reinforced Concrete system in 1900.[14] In 1905 Monash founded the Reinforced Concrete & Monier Pipe Construction Company, in partnership with David Mitchell, the manufacturer of Emu Portland Cement.[15] Within the same year, the St Kilda Street Bridge was designed and constructed in 1905 under an agreement with the Public Works Department.

3.2.4 St Kilda Bridge structural details and condition assessment

VicRoads engaged GHD in August 2014 to conduct an inspection on the St Kilda Street Bridge over the Elwood Canal in Elwood, Victoria. The inspection was required to determine the current condition of the structure and the nature and extent of deterioration to enable determination of repair methods, followed by preparation of drawings for the rehabilitation of the bridge.[16] The results of this report have been summarized below.

The bridge is a five span reinforced concrete bridge 30.5 m long and 10.7 m wide (inclusive of a 1.7 m wide footpath). The substructure is constructed from 48 columns arranged in six rows (two abutments and four piers) of eight columns. The eight concrete girders are 260 mm in width and 480 mm in depth, orientated in the direction of the span of the bridge. No transverse girders or column headstocks have been provided on the bridge.

The deck comprises a 127 mm (5”) thick slab spanning transversely between girders. No bearings have been provided and the deck slab has been cast integral with the beams and columns.

St Kilda Street Bridge is generally in poor condition with deterioration observed in the concrete elements (GHD 2014). General cracking and spalling to the face of all concrete elements was observed which will require remedial works to maintain the structure in a serviceable condition.

[14] Brian Lewis (1980) Our War: Australian during World War I, Melbourne University Press, Victoria, p. 93
[15] Henry Cowan (1998) From Wattle and Daub to Concrete and Steel: The Engineering Heritage of Australia's Buildings. Melbourne University Press , p. 92
[16] Adam Ritchie (2014) St Kilda St Bridge Remediation Condition Assessment Report. GHD, Victoria. Unpublished Report for VicRoads Metropolitan North West Region, pp. 5-10

Plate 1 Current condition of the St Kilda St Bridge (Ritchie 2014, p. 1)

The inspection identified a number of defects that require remediation to prevent further deterioration of the bridge. The significant defects identified during the inspection include:[17]

- **Barriers** – Breakdown of protective coating and corrosion to all steel barrier elements on the Western barrier. Failure of the eastern barrier post and non-conformance of both barriers with current Australian Standards.
- **Deck** – Spalling of deck soffit, corrosion and section loss of reinforcement and advanced wear of the footpath wearing surface.
- **Superstructure** – Spalling of concrete beams, corrosion and section loss of reinforcement, shear and flexural tensile cracking of concrete beams.
- **Substructure** – Spalling of concrete, corrosion and section loss of reinforcement in columns, and abutment walls and flexural tensile cracking to concrete columns.

Rehabilitation works are being planned for 2015 by VicRoads to return the bridge to a serviceable condition. Currently there is a load limit of 4.5 tonnes imposed by VicRoads to reduce the risk of further damage to the bridge from vehicle traffic. The load limit is likely to stay in place even after the rehabilitation works are implemented so as to prolong the serviceable life of the bridge. A permit for the proposed works was issued by Heritage Victoria on 23 January 2015 (Appendix B).

3.2.5 Further research

Considerable work has been undertaken by researchers Geoff Taplin, Alan Holgate and Lesley Alves on the work of General Sir John Monash and the implementation of reinforced concrete girder bridges in Australia prior to World War I. This research project into 'The Early Engineering Work of Sir John Monash Prior to World War One' was conceived at Monash University by Geoff Taplin in 1994 and continues today.

More information on this topic can be found on Alan Holgate's project website: http://www.aholgate.com/mainpages/research.html

[17] Ibid, p. 10

3.3 Heritage listings

3.3.1 Heritage Victoria

Name: St Kilda Street Bridge

Level of Significance: Registered

Victorian Heritage Register Number (VHR): H2080

Date Listed: Unknown

Note: Extent of registration includes the St Kilda Street Bridge over the Elwood Canal on St Kilda Street Elwood including all of the bridge and its support structure, the abutments, the roads and embankments marked (B1) on Diagram 2080 held by the Executive Director.

3.3.2 National Trust of Victoria

Name: St Kilda Street Bridge over the Elwood Canal

Level of Significance: National

Heritage Inventory Number (HI): B7260

Date Listed: 17 May 2004

3.3.3 City of Port Phillip Heritage Overlay

Name: St Kilda Street Bridge

Level: Registered

Heritage Overlay Numbers: HO461, HO770

Date Listed: Unknown

4. Assessment of significance

4.1 Historical significance

The St Kilda Street Bridge was designed and constructed in 1905 by civil engineer General Sir John Monash of the Reinforced Concrete & Monier Pipe Construction Company. The St Kilda Street Bridge construction marks a turning point in the use of reinforced concrete in not only civil construction but also in the construction of buildings. The St Kilda Street Bridge is of historical significance for its association with General Sir John Monash, demonstrating the technical innovation achieved by General Sir John Monash in the early years of the twentieth century and the earliest stage in the development of reinforced concrete technology in Australia. The St Kilda Street Bridge is the oldest extant reinforced concrete beam bridge in Victoria and possibly Australia.

4.2 Historic individuals or associations

The St Kilda Street Bridge has a strong association with the lives and works of:

- General Sir John Monash
- Reinforced Concrete & Monier Pipe Construction Company
- Joseph Monier

4.3 Creative or technical achievement

The St Kilda Street Bridge is of technical significance as Victoria's earliest surviving example of the type of reinforced concrete girder bridges developed by General Sir John Monash in the early twentieth century.

The bridge demonstrates the earliest stage in the development of reinforced concrete girder technology for bridge building and reflects a change in technical engineering practice in the turn of the century. The bridge represents a major engineering achievement in Australia prior to World War I.

Between 1905 and 1907 seven bridges were built by Monash and the Reinforced Concrete & Monier Pipe Construction Company in the Elwood district. Reinforced concrete was subsequently adopted as standard bridge building material in Victoria.

The St Kilda Street Bridge is a functional and visually unexceptional structure consistent with the location, low cost innovation and historic context of the bridge.

4.4 Research potential

The St Kilda Street Bridge has the potential to yield further information that will contribute to an understanding of the engineering work of General Sir John Monash and the implementation of reinforced concrete girder bridges in Australia prior to World War I.

4.5 Social

The St Kilda Street Bridge demonstrates the historic connection between the rapid pre-war expansion of Elwood and the technological innovation critical to the achievement of this social change. The St Kilda Street Bridge had a profound social impact within Australia as it was the first successful bridge of this type in Victoria. This led to the construction of a large number of 'T' beam reinforced concrete bridges for the vast majority of road bridges and also for many rail bridges. These bridges proved to be strong, resistant to fire and flood damage and cost effective.

The St Kilda Street Bridge is also associated with the effective drainage works that ultimately led to the subdivision and development of the suburb of Elwood.

4.6 Rarity

General Sir John Monash designed and built forty-nine girder bridges in Victoria between 1904 and 1915. As of 1998, thirty of these bridges had survived and nineteen girder bridges had been replaced (four within the City of Elwood).[18]

The St Kilda Street Bridge is a representative example of reinforced concrete girder bridges designed and built by Monash prior to World War 1. The bridge demonstrates the principal characteristics of the functional design developed by the Monash and the Reinforced Concrete & Monier Pipe Construction Company.

As the oldest extant reinforced concrete beam bridge in Victoria, and possibly Australia, the bridge is an important addition to the list of sites of national significance recognised by the Engineering Heritage Recognition Program.

4.7 Representativeness

The St Kilda Street Bridge is important in demonstrating the principal characteristics of T-girder reinforced concrete bridges designed and built by General Sir John Monash prior to WWI.

4.8 Integrity/Intactness

The St Kilda Street Bridge appears to remain as originally constructed. However, VicRoads engaged GHD in August 2014 to conduct an inspection on the St Kilda Street Bridge to identify any rehabilitation works. The inspection identified a number of defects that require remediation to prevent further deterioration of the bridge. Proposed rehabilitation works include:[19]

- Repairs to areas of cracked and spalled concrete.
- Application of an anti-carbonation coating to the surface of concrete elements.
- Re-instatement of a pedestrian barrier and connections to the deck.

The proposed work aims to rehabilitate the structure to a serviceable condition while retaining as much of the original character of the bridge as possible. The methodology developed for rehabilitation minimises the impact of the repairs on the existing bridge profile and aims to maintain the bridge's heritage significance while remaining serviceable to the public.

The proposed works have been assessed and were approved on 23 January 2015 by Heritage Victoria under the *Heritage Act 1995*(Vic) (Appendix B).

[18] L Alves, A Holgate & G Taplin. 'Monash Bridges: Typology study of Reinforced Concrete Bridges in Victoria 1897-1917'
[19] Adam Ritchie (2014) St Kilda St Bridge Remediation Condition Assessment Report. GHD, Victoria. Unpublished Report for VicRoads Metropolitan North West Region, p. 3

5. Statement of significance

The design and construction of the St Kilda Street Bridge by General Sir John Monash in 1905 is historically significant because it represents a turning point in the use of reinforced concrete technology in Australia.

Prior to the construction of the St Kilda Street Bridge, the use of reinforced concrete in bridges was limited to Monier arch bridges which were designed such that the arch carried only compressive stresses and the reinforcement carried only unpredicted local tensile stresses. The use of reinforced concrete in T-girders bridges relied on the reinforcement to carry large tensile stresses rather than only localised stresses.

The St Kilda Street Bridge is Victoria's first successful example of a reinforced concrete T-girder bridge and is historically significant in the development of reinforced concrete technology. Following the successful completion of the St Kilda Street Bridge, General Sir John Monash advocated the adoption of the T-girder bridge in preference to the arch; many other reinforced concrete T-girder bridges were constructed in the early twentieth century during the rapid expansion of the Victorian road network. These bridges proved to be cost effective, strong, durable, and resistant to fire and flood damage.

The technical innovation by General Sir John Monash advanced the field of structural engineering and had a profound impact on not only civil construction but also the construction of buildings. The engineering principles used by Monash in the design and construction of the St Kilda Street Bridge are still extensively used in the design of concrete structures to this day.

The St Kilda Street Bridge is socially significant for its associations with the Public Work Office's effective drainage works and development scheme that led to the subdivision and development of the suburb of Elwood.

6. Interpretation plan

6.1 General approach

The strategy for interpretation of the Engineering Heritage Works is laid out in EHA's "Guide to the Engineering Heritage Recognition Program" (November 2012). The general approach towards an interpretation strategy will be to mark the works with an appropriate category of heritage marker; a public ceremony to unveil that marker; and an interpretation panel which summaries the heritage and significant features of the works for the public.

This Plan provides a summary of the proposals for design, content, manufacture and funding of the proposed St Kilda Street Bridge interpretation panel.

6.2 Heritage recognition ceremony

The ceremony will be held on 18 April 2015 at the St Kilda Street Bridge. VicRoads is organising the ceremony and will produce a Ceremony Brochure prior to the event which will be incorporated into this report at a later stage. The ceremony report including photos will be attached within the report after the ceremony.

6.3 Structure of the interpretation panel for St Kilda Street Bridge

In accordance with the latest designs, the interpretation panel will comprise a waist height self-standing panel. The panel will be constructed with vitreous enamel-on-steel plate with flanges as per Owen Peake's designs (drawn 14 April 2011, revised 7 August 2014), supplied by VicRoads (Appendix C).

The interpretation panel will technically be constructed and erected as follows:

- The panel will stand approximately 950 mm above ground level with an additional 700 mm depth below ground.
- The interpretation panel, itself, will sit at a 45 degree angle.
- The interpretation panel frame will have the approximate dimensions of 1200 mm by 600 mm.
- The edges of the panel will be folded down approximately 40 mm around the entire panel.

6.4 Design process for the panel content

The basic interpretation panel content will be initially drafted by GHD and developed in conjunction with VicRoads on behalf of Engineering Heritage Australia.

When satisfactory design content has been achieved by VicRoads, it will be submitted for the approval of the Engineering Heritage Australia HR Committee. Approval of both the draft design and content will need to be approved by the Committee before the Interpretation Panel is finalised.

6.5 Location of the interpretation panel and heritage marker

The location of the interpretation panel has not yet been decided upon by VicRoads and Engineering Heritage Australia. The panel will be located within close proximity of the St Kilda Street Bridge at a suitable viewpoint for readers. The current proposed location is along the southern edge of the bank downstream from the bridge, adjacent to the shared used path.

6.6 Manufacture and funding

Quotations for the interpretation panel will be sought from manufacturers. A preferred tender will be selected on the basis of quality, price and time-estimates. VicRoads will be funding the manufacture of the interpretational panel. On-going maintenance is yet to be decided.

6.7 Possible interpretation themes for interpretation panel

In accordance with the EHA's "Guide to the Engineering Heritage Recognition Program", the content of the panel will be divided into three themes for ease of understanding by the public. The following themes have been assessed as possible themes for the Interpretation Panel:

- History – Primary Theme
- Engineering Design – Secondary Theme
- Significance – Tertiary Theme

Total text should not exceed 500 words excluding headings.

6.8 Preliminary text blocks for interpretation panel

History

Formerly known as the Elwood Canal Bridge the St Kilda Street Bridge was designed and constructed in 1905 by renowned civil engineer John Monash (later General Sir John) and his Reinforced Concrete and Monier Pipe Construction Company. The bridge was built as part of a £30,000 Public Works Department scheme to solve ongoing drainage problems in the low lying swampy land of the Elsternwick and Elwood districts.

The Elwood Canal provided Monash the opportunity to present to Carlos Catani, the then Chief Engineer of the Public Works Department, the largely untried reinforced concrete girder technology for bridge building, a cheaper alternative to the existing iron trough girder and concrete bridges. Monash won a tender for design and construction of the bridge subject to a test with a 15 ton steam roller and that only half of the £1500 quotation fee would be paid before the bridge satisfactorily passed testing.

The tender was submitted in April 1905, construction commenced in July 1905 and completed in September. A load test with a steam roller was undertaken on 20 November 1905 in the presence of Catani, the St Kilda city surveyor and municipal representatives from Brighton and Caulfield.

Despite its technological innovation the bridge was opened the following week without ceremony.

Word count 209

Engineering design

The bridge consists of five-equal spans of 20 feet (6.1 m) with a 30 degree skew and a total width of 40 feet comprising of 30 feet of road carriageway and 10 feet for a footpath on the downstream side. The superstructure has seven lines of "T" girders spaced 4 feet 8 inches (1.42 m) apart. There are six columns supporting each span with no transverse beams supporting the deck slab. The columns are supported by individual spread footings in the form of a truncated pyramid. The column heads incorporate small corbels in the direction of the span. The abutments consist of a row of columns, each supporting the end of one girder, backed by precast concrete panels to retain the earth of the embankment.

The engineering success of the St Kilda Street Bridge led to the construction of many other reinforced concrete T-girder bridges throughout Victoria in the early twentieth century. These bridges proved to be cost effective, strong, durable, and resistant to fire and flood damage.

Word count 170

Significance

The St Kilda Street Bridge demonstrates the earliest stage in the development of reinforced concrete girder technology for bridge building. It is the earliest existing example in Victoria, and possibly in Australia, of the technological innovation achieved by Monash and his company. Between 1905 and 1907 seven bridges were built by the company in the Elwood district, six across the Elwood Canal. Reinforced concrete was subsequently adopted as standard bridge building material in Victoria. By 1915 Monash's firm had built around 70 reinforced concrete bridges in Victoria.

The bridge is also associated with the effective drainage works that ultimately led to the subdivision and development of the suburb of Elwood.

Word count 111

Total word count: 490

7. References

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Appendices

Appendix A – Images

Figure A1 St Kilda Street Bridge testing with a fifteen ton steam roller in 1905 (source *The Australasian* (1906, August 11), p. 32)

Kaiserliches Patentamt. Ausgegeben den 4. Aug. 1881.

PATENTSCHRIFT
Nr. 14673

Klasse 80: Ton- und Steinwarenindustrie.

JOSEPH MONIER IN PARIS

Verfahren zur Herstellung von Gegenständen verschiedener Art aus einer Verbindung von Metallgerippen mit Zement.

Patentirt im Deutschen Reiche vom 22. Dezember 1880 ab.

Nach diesem Verfahren werden Gefäße aller Art aus mit Zement umgossenen Metallgerippen hergestellt, wodurch größere Haltbarkeit, Ersparnis an Zement und Arbeit bezweckt wird.

Fig. 1 bis 4 zeigen die Anwendung des Verfahrens zur Herstellung von Eisenbahnschwellen.

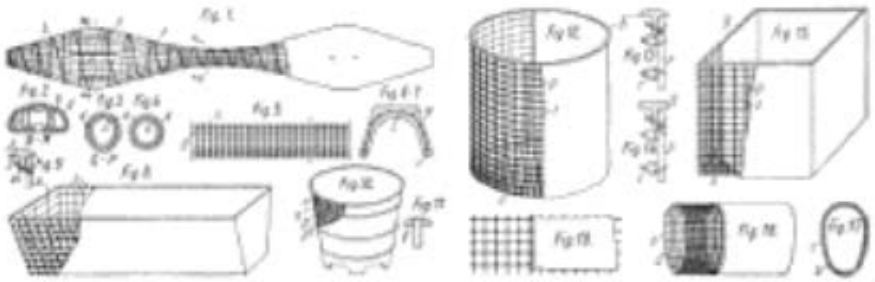
Fig. 1 ist eine Ansicht,
Fig. 2 ein Schnitt nach M-N,
Fig. 3 ein Schnitt nach P-Q,
Fig. 4 eine Ansicht der Enden der Schwelle.

Die Schwelle in unregelmäßiger Form besteht aus zwei nebeneinanderliegenden Ovalen, die an derjenigen Stelle ihre größte Weite haben, an welcher die Schienen aufliegen.

Die Schwelle ist somit an den Enden schmal auslaufend und in der Mitte zusammengezogen und ist in der Gegend der größten Belastung unten flach und oben rund, wie der Schnitt Fig. 2 zeigt.

Diese Schwellen werden aus Querringen a hergestellt, die durch eiserne Längsstäbe b und Verbindungen c c miteinander verbunden sind; das Ganze wird noch mit einem starken Bandeisen d schraubenförmig umwickelt.

Die Schienenlager oder auch die Schienen selbst ruhen an der breitesten Stelle der Schwellen auf Platten e, welche von unten durch Stehbolzenrahmen f f geschützt werden.



Patent Monier.

Figure A2 The German Monier Patent 1851 (source Kurrer 2012, p. 453)

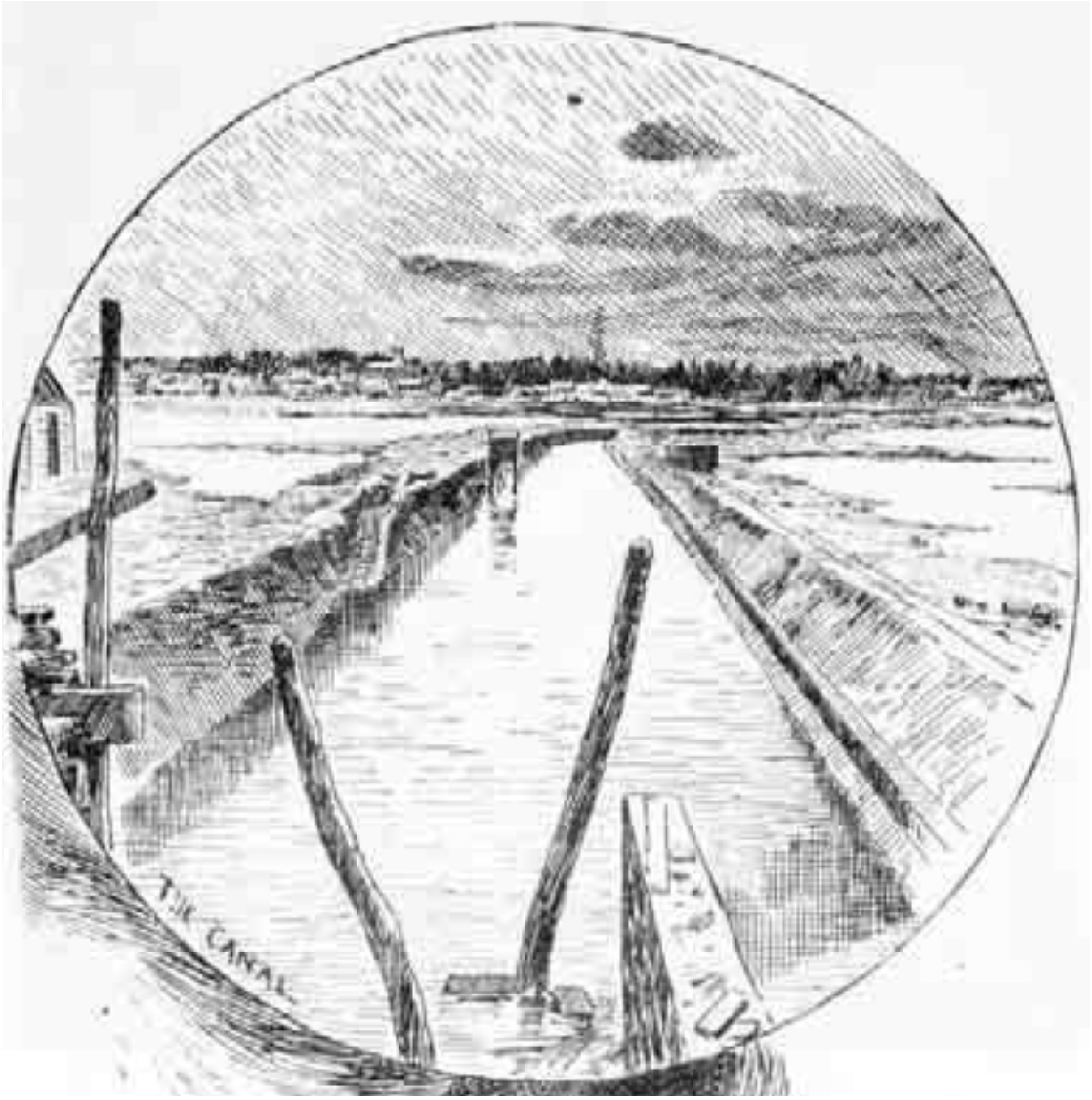


Figure A3 Illustration demonstrating the Elwood Canal under construction in 1889 (source Reeves and Wixted, 2005, p. 19)

Figure A4 Location of heritage interpretation panel west of bridge 2014

Figure A5 Underside of bridge 2014

Figure A6 St Kilda Bridge roadway 2014

Appendix B – Approved Permit to undertake works at St Kilda Street Bridge

Department of Environment, Land, Water & Planning

Permit Application No: P22516
File No: PL-HE/03/0176

1 Spring Street
Melbourne Victoria 3001 Australia
Telephone: 03 9208 3333
www.delwp.vic.gov.au
DX210292

Mr Luay Butrus
VicRoads
Metropolitan North West Region
499 Ballarat Road
SUNSHINE VIC 3020

Dear Mr Butrus

RE: PERMIT APPLICATION P22516 - ST KILDA STREET BRIDGE, ST KILDA STREET ELWOOD and ST KILDA STREET BRIGHTON (H2080)

Thank you for your permit application to undertake works or activities at the above place.

After assessing your application against the relevant criteria in the *Heritage Act 1995* I have determined to issue a permit with conditions (see enclosed). Please read the conditions of the permit carefully.

If you feel any of the conditions are unsatisfactory, you may appeal my decision to the Heritage Council of Victoria. An appeal against conditions of the permit must be lodged with the Heritage Council within 60 days of this permit. Appeal forms can be obtained online at: www.dtpli.vic.gov.au/heritage/permits/permit-appeals or by phoning the Heritage Council Hearings Officer on (03) 9208 3666.

Please note that the works must be carried out in accordance with the permit and you must give the Executive Director five working days notice of the commencement of the approved works.

Please contact Heritage Victoria's Permits Co-ordinator on (03) 9208 3349 or by email at heritage.permits@dtpli.vic.gov.au if you wish to discuss this permit further.

Yours sincerely

J Sullivan

TIM SMITH
Executive Director
HERITAGE VICTORIA

cc Manager Statutory Planning, Port Phillip City Council
cc Adam Ritchie, GHD Pty Ltd

23/1/2015

Privacy Statement

Any personal information about you or a third party in your correspondence will be collected, held, managed, used, disclosed or transferred in accordance with the provisions of the **Information Privacy Act 2000 (Vic)** and applicable laws. Enquiries about access to information about you held by the Department should be directed to the Privacy Officer, Department of Environment, Land, Water & Planning, PO Box 2392, Melbourne, VIC 3001.
Notwithstanding the above, please note that information provided to enable the administration of the Heritage Act 1995 may be disclosed to persons with an interest in the heritage place or object particularly, and information provided as part of a permit application may be made available on-line where the application has been publicly advertised under section 68 of the Heritage Act 1995.

State Government Victoria

HERITAGE PERMIT GRANTED UNDER SECTION 74 OF THE HERITAGE ACT 1995

Permit No.: P22516

Owner/s: Vic Roads
Metropolitan North West Region
499 Ballarat Road
SUNSHINE
VIC 3020

NAME OF PLACE/OBJECT: **ST KILDA STREET BRIDGE**

HERITAGE REGISTER NUMBER: **H2080**

LOCATION OF PLACE/OBJECT: ST KILDA STREET ELWOOD and ST KILDA STREET BRIGHTON

THE PERMIT ALLOWS: ***Conservation and repair works, in accordance with the following documents, as endorsed by the Executive Director and forming part of this permit:***

31-31909-S001 Rev. A Deck and Girder Defect Plan
31-31909-S002 Rev. A Girder 1 Defect Plan
31-31909-S003 Rev. A Girder 2 Defect Plan
31-31909-S004 Rev. A Girder 3 Defect Plan
31-31909-S005 Rev. A Girder 4 Defect Plan
31-31909-S006 Rev. A Girder 5 Defect Plan
31-31909-S007 Rev. A Girder 6 Defect Plan
31-31909-S008 Rev. A Girder 7 Defect Plan
31-31909-S009 Rev. A Girder 8 Defect Plan
31-31909-S010 Rev. A Abutment 2 Defect Plan
31-31909-S011 Rev. A Abutment 1 Defect Plan
31-31909-S012 Rev. A Defect Schedule
31-31909-S013 Rev. A Hand Rail and Topping Slab Details
St Kilda Street Bridge Remediation, Condition Assessment Report
St Kilda Street Bridge Remediation, Specification for Repair Works

THE FOLLOWING CONDITIONS APPLY TO THIS PERMIT:

1. Prior to the commencement of works detailed information regarding the proposed anti-carbonation coating is to be provided for the written approval of the Executive Director. It is preferred that this coating should be clear so as not to obscure the bridges concrete finishes.
2. It is the Executive Director's preferred option that as much of the existing original metal handrail to the western side of the bridge is retained as possible. Prior to the commencement of works a survey detailing the condition of each individual member of the handrail and an amended proposal to repair handrail, replacing only unserviceable and unrepairable members, is to submitted for the written approval of the Executive Director.
3. This permit shall expire if the permitted works have not commenced within two (2) years of the date of issue of this permit, or are not completed within four (4) years of the date of issue of this permit unless otherwise agreed in writing by the Executive Director, Heritage Victoria.
4. The Executive Director is to be given five working days notice of the intention to commence the approved works.
5. Approved works or activities are to be planned and carried out in a manner which prevents damage to the registered place / object. However, if other previously hidden original or inaccessible details of the object or place are uncovered, any works that may affect such items shall immediately cease. The Executive Director shall be notified of the details immediately to enable Heritage Victoria representatives to inspect and record the items, and for discussion to take place on the possible retention of the items, or the issue of a modified approval.
6. All works must cease and this office be contacted if historical archaeological artefacts or deposits are discovered during any excavation or subsurface works. Should any munitions or other potentially

IMPORTANT INFORMATION ABOUT THIS PERMIT

WHAT HAS BEEN DECIDED?

The Executive Director has issued a permit under section 74 of the ***Heritage Act 1995***.

WHEN DOES THE PERMIT BEGIN?

The permit operates from a day specified in the permit.

WHEN DOES A PERMIT EXPIRE?

A permit expires if -

* the development or any stage of it does not start within the time specified in the permit; or
* the development or any stage is not completed within the time specified in the permit, or, if no time is specified, within two years after the issue of the permit.

The expiry of a permit does not affect the validity of anything done under that permit before the expiry.

WHAT ABOUT APPEALS?

The applicant or the owner of a registered place or registered object may appeal to the Heritage Council against any condition of a permit imposed by the Executive Director on a permit issued under Section 74 of the Heritage Act.

An appeal must -

* be in writing; and.
* be lodged within 6o days after the permit is issued.

Appeal forms can be downloaded at: www.dtpli.vic.gov.au/heritage/permits/permit-appeals

explosive artefacts be discovered, Victoria Police is to be immediately alerted whilst the site is cleared of all personnel.

7. The Executive Director is to be informed when the approved works have been completed.
8. The development approved by this permit is to be carried out in accordance with the endorsed drawings, unless otherwise agreed in writing by the Executive Director, Heritage Victoria.

NOTE THAT PERMISSION HAS BEEN GIVEN FOR INSPECTIONS OF THE PLACE OR OBJECT TO BE UNDERTAKEN DURING THE CARRYING OUT OF WORKS, AND WITHIN SIX (6) MONTHS OF NOTIFICATION OF THEIR COMPLETION.

TAKE NOTICE THAT ANY NATURAL PERSON WHO CARRIES OUT WORKS OR ACTIVITIES NOT IN ACCORDANCE WITH THE PERMIT OR CONDITIONS IS GUILTY OF AN OFFENCE AND LIABLE TO A PENALTY OF UP TO 2,400 PENALTY UNITS ($346,464) OR 5 YEARS IMPRISONMENT OR BOTH, OR IN THE CASE OF A BODY CORPORATE 4800 PENALTY UNITS ($692,928).

THE ATTENTION OF THE OWNER AND/OR APPLICANT IS DRAWN TO THE NEED TO OBTAIN ALL OTHER RELEVANT PERMITS PRIOR TO THE COMMENCEMENT OF WORKS.

Date Issued:	**Signed on behalf of the Executive Director, Heritage Victoria:**	HERITAGE VICTORIA HERITAGE VICTORIA HERITAGE VICTORIA
23 January 2015	J Sullivan	

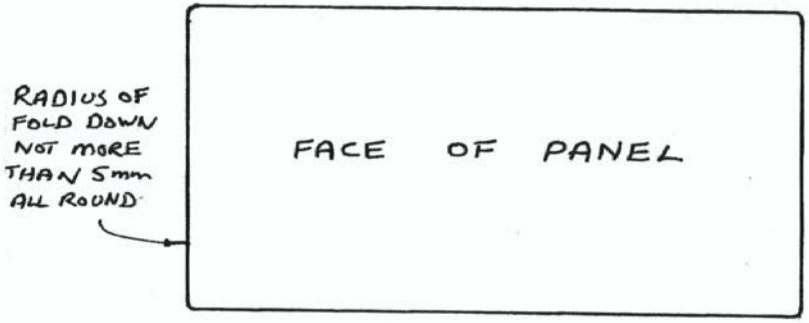
(If the permit has been amended, include the following table indicating the date and nature of amendments included in the amended permit)

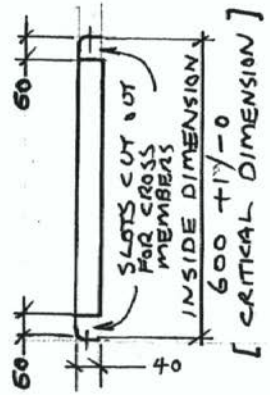
Date of amendment	Brief description of amendment

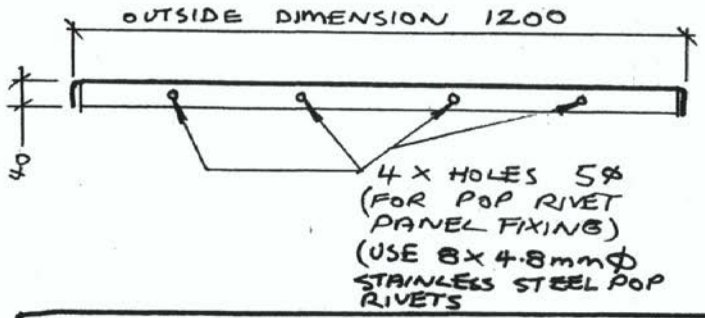
Appendix C – Interpretation Panel and Mounting Frame Drawings

DIMENSIONS IN mm

SCALE: NOT TO SCALE







NOTES:

1) EDGES FOLDED DOWN ALL ROUND 40 mm
2) PANEL REFLECTIVE VINYL FILM WITH UV LAMINATE ON ALUMINIUM SHEET

INTERPRETATION PANEL

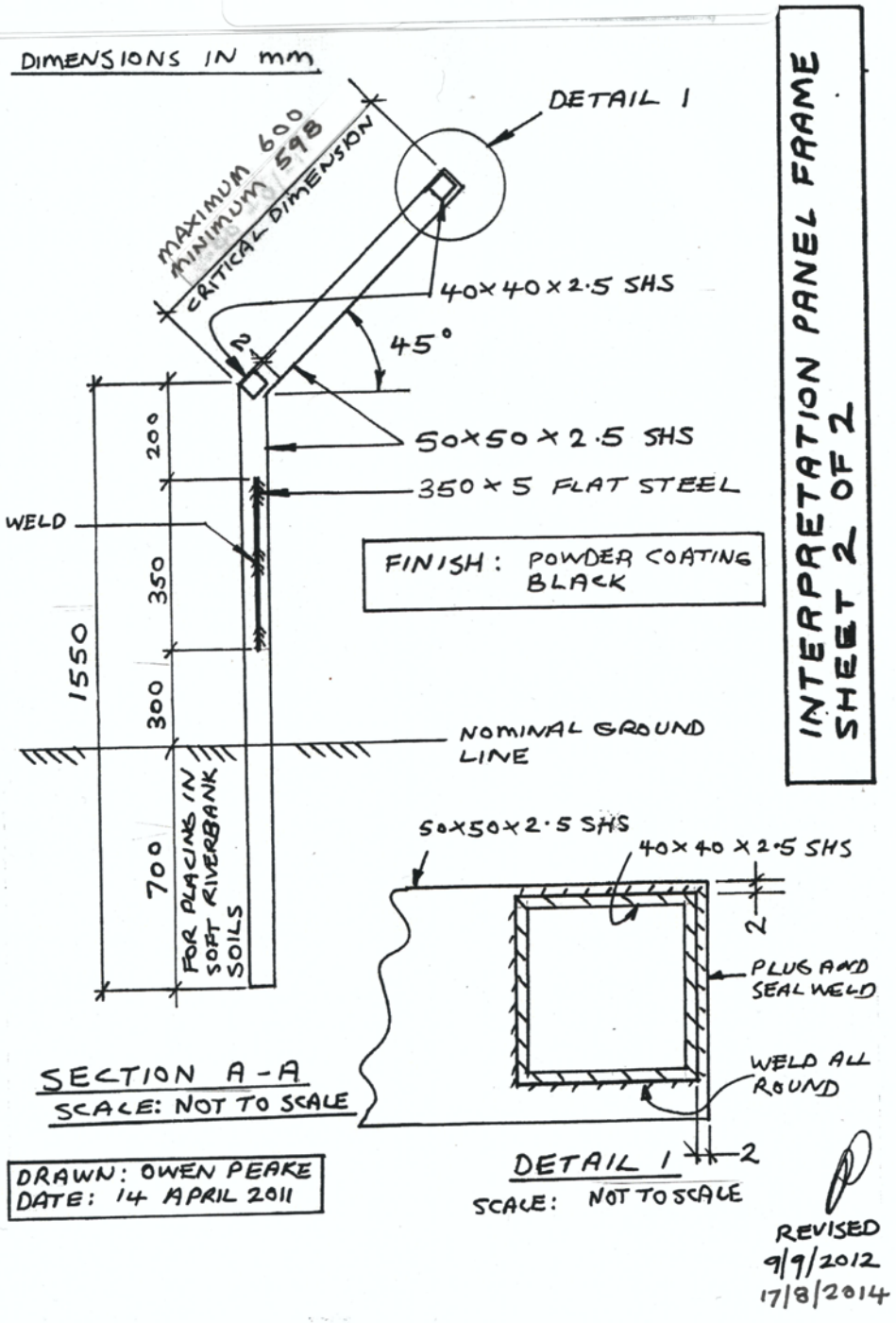
STANDARD PANEL (VINYL-ON-ALUMINIUM)

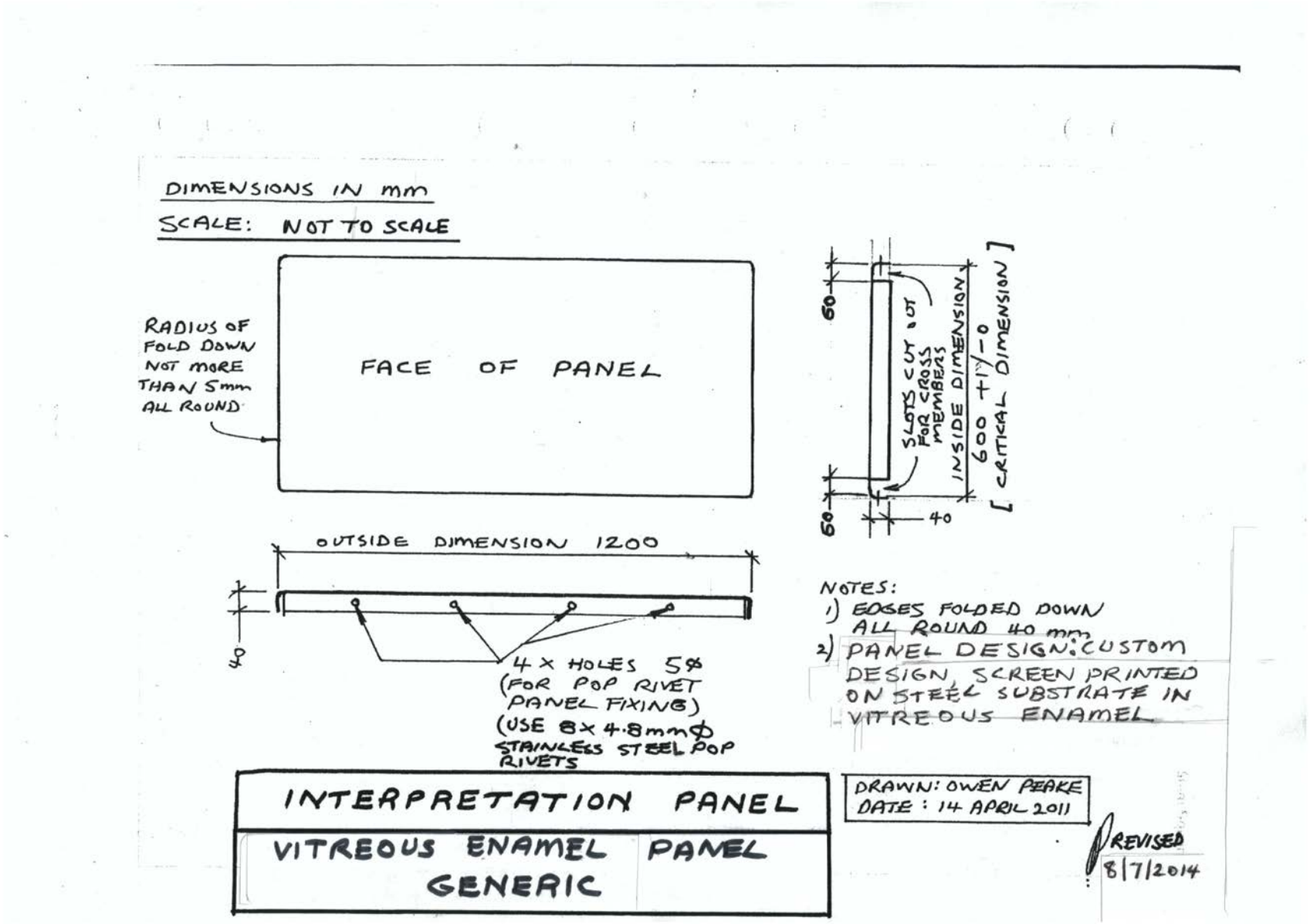
DRAWN: OWEN PEAKE
DATE : 14 APRIL 2011

REVISED 19/9/2013

DRAWING No: EHA007

GHD | Report for VicRoads - St Kilda Street Bridge, 31/32461


INTERPRETATION PANEL FRAME
SHEET 2 OF 2
DIMENSIONS IN mm
DETAIL 1
MAXIMUM 600
MINIMUM 598
CRITICAL DIMENSION
40×40×2.5 SHS
45°
50×50×2.5 SHS
350×5 FLAT STEEL
WELD
FINISH: POWDER COATING BLACK
1550
200
350
300
700
NOMINAL GROUND LINE
FOR PLACING IN SOFT RIVERBANK SOILS
SECTION A-A
SCALE: NOT TO SCALE
50×50×2.5 SHS
40×40×2.5 SHS
2
PLUG AND SEAL WELD
WELD ALL ROUND
DETAIL 1
SCALE: NOT TO SCALE
DRAWN: OWEN PEAKE
DATE: 14 APRIL 2011
REVISED
9/9/2012
17/8/2014


DIMENSIONS IN mm
SCALE: NOT TO SCALE
RADIUS OF FOLD DOWN NOT MORE THAN 5mm ALL ROUND
FACE OF PANEL
OUTSIDE DIMENSION 1200
4
4 x HOLES 5ø (FOR POP RIVET PANEL FIXING)
(USE 8 x 4.8mmø STAINLESS STEEL POP RIVETS
60
60
40
SLOTS CUT OUT FOR CROSS MEMBERS
INSIDE DIMENSION
600 +1/-0
[CRITICAL DIMENSION]
NOTES:
1) EDGES FOLDED DOWN ALL ROUND 40 mm
2) PANEL DESIGN: CUSTOM DESIGN SCREEN PRINTED ON STEEL SUBSTRATE IN VITREOUS ENAMEL
INTERPRETATION PANEL
VITREOUS ENAMEL PANEL
GENERIC
DRAWN: OWEN PEAKE
DATE : 14 APRIL 2011
REVISED
8/7/2014

Appendix D – Ceremony

The ceremony will be held on 18 April 2015 at St Kilda Street. VicRoads is organising the ceremony and will produce a Ceremony Brochure prior to the event which will be incorporated into Appendix D at a later stage. The ceremony report including photos will be attached in Appendix D after the ceremony.

GHD

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Document Status

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		Name	Signature	Name	Signature	Date
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